ABSTRACT

DETERMINATION OF EROS PHYSICAL PARAMETERS FROM EARLY NEAR EARTH ASTEROID RENDEZVOUS ORBIT PHASE NAVIGATION DATA

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Navigation of the orbit phase of the Near Earth Asteroid Rendezvous (NEAR) mission will require determination of certain physical parameters describing the size, shape, gravity field, attitude and inertial properties of Eros. Prior to launch, little was known about Eros except for its orbit which could be determined with high precision from ground based telescope observations. Radar bounce and light curve data provided a rough estimate of Eros shape and a fairly good estimate of the pole, prime meridian and spin rate. However, the determination of the NEAR spacecraft orbit requires a high precision model of Eros's physical parameters and the ground based data provides only marginal *a priori* information. Eros is the principal source of perturbations of the spacecraft's trajectory and the principal source of data for determining the orbit. The initial orbit determination strategy is therefore concerned with developing a precise model of Eros.

The original plan for Eros orbital operations was to execute a series of rendezvous burns beginning on December 20,1998 and insert into a close Eros orbit in January 1999. As a result of an unplanned termination of the rendezvous burn on December 20, 1998, the NEAR spacecraft continued on its high velocity approach trajectory and passed within 3900 km of Eros on December 23, 1998. The planned rendezvous burn was delayed until January 3, 1999 which resulted in the spacecraft being placed on a trajectory that slowly returns to Eros with a subsequent delay of close Eros orbital operations until February 2000. The NEAR spacecraft entered into orbit about Eros on February 14, 2000. Subsequent orbit correction maneuvers reduced the orbit in stages to a 50 Km radius circular polar orbit.

The initial attitude and spin rate of Eros, as well as estimates of reference landmark locations, are obtained from images of the asteroid. These initial estimates are used as *a priori* values for a more precise refinement of these parameters by the orbit determination software which combines optical measurements with Doppler tracking data to obtain solutions for the required parameters. As the spacecraft was maneuvered closer to the asteroid, estimates of spacecraft state, asteroid attitude, solar pressure, landmark locations and Eros physical parameters including mass, moments of inertia and gravity harmonics were determined with increasing precision.

In this paper, estimates of Eros physical parameters obtained from the early orbit phase will be presented. This new knowledge will be applied to orbital operations to be conducted late in 2000 and early 2001.

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